

XIII. *Experiments upon Air, and the effects of different kinds of Effluvia upon it; made at York.* By W. White, M. D. F. S. A. Communicated by John Fothergill, M. D. F. R. S.

Read Feb. 5, 1778. THE experiments of which the following are only a part, and which I purpose at my leisure to pursue farther, were originally undertaken with the design of ascertaining the state of the common atmospheric air in and about this city. But in order to form a just idea of this, it seemed to me necessary to find, by exact experiments, the real effects of the different kinds of effluvia upon air, especially such as are in a natural state constantly mixing with the atmosphere, and to the effects of which all respiring animals are constantly exposed; such are those from animal and vegetable substances, and from different kinds of soils. As the result of those inquiries appeared to me not only curious, but in a medical view very interesting, I am in hopes they may be acceptable to the Royal Society.

It may not be amiss to premise a short description of the soil and situation of this city.

It is for the most part built upon a morass; this is more particularly the case in the part of the city situated to the East of the river, which is much the largest. The soil to the West of it is more of a sand or clay. It is divided into two unequal parts by the navigable river Ouse, running from N.W. to S.E. Its situation is in the middle of an extensive vale, well cultivated, and drained in general; nor is it kept very moist and unventilated by numerous thick woods. We have no very high grounds near us, but at some miles distance, especially to the N. and E. are high hills of great extent, called the Wolds. To the South there is a gradual descent down to the Humber. Our waters are in general hard: we have one or two springs of exceeding pure, soft water. Some of our springs contain a considerable quantity of various neutral salts, especially the magnesia and Glauber's salt, so as to be purgative: we have two or three pretty strongly chalybeate. The highest state of the barometer in the three last years was 30.58; the lowest, 28.20. Thermometer in the shade, highest, 81; lowest, 8. Having no Ombrrometer, shall only observe in regard to rain, that in 1774 we had 193 days in which more or less rain fell; in 1775, 232 days; and in the last year, 240.

Besides the navigable river Ouse, we have a brook called the Foss, which, rising about twelve miles Eastwards of the city, runs towards it, and, washing the castle walls, empties itself into the Ouse. This stream, after floods and in winter, overflows a large quantity of land, which in summer and autumn becomes an offensive, stinking morass, almost surrounding the East part of the city. The unhealthfulness of the evaporation from some hundred acres of stinking mud, is farther increased by its being made a receptacle for all kinds of nastiness; in this respect we are more remiss than our ancestors. This has been its state many ages: LELAND thus speaks of it, *Fossa amnis piger, instar stagnantis aquæ collectæ ex pluvia et terræ uligine, originem habet &c.*" In the thirtieth year of EDWARD the third, before the king at York, divers persons were punished for erecting *porcariae* [hog's-stytes] upon the banks of the foss: and in HENRY the fourth's time the throwing in of dung and other nastiness into the foss was forbid under the severe fine of one hundred pounds, as we find in DRAKE's *Eboracum*. This was all done for the preservation of the fish; I wish it was now attended to for a more important purpose. The draining of it has been some time in agitation, the utility of which is obvious.

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The apparatus used in making the following experiments is very simple; and, though less ostentatious, may perhaps be more accurate than more complete instruments. First, a vessel full of water, of a proper size and figure. Secondly, a common barometer tube of a large bore, so that an ounce phial full of air, being introduced into it, occupied at a medium  $1\frac{3}{4}$  decimal parts of an inch; and upon a further addition of an half-ounce phial of nitrous air, 205: this tube is graduated by inches and decimals. Thirdly, glass funnels, with necks of such a size as to enter the tube.

The air, the subject of the experiment, was conveyed into the tube, by means of the glass funnel, under water; the nitrous air is then added to it by the same method. The space occupied by them both, immediately upon mixture, is noted down, as also the time by a watch: after standing the appointed time (half an hour, except where it is mentioned otherwise) the space then occupied is marked down, which being deducted from the first gives the result of diminution sought for: for example, an ounce phial of air from a putrid plumb, with the addition of half of nitrous air, took up the space of 195 (part of the first being absorbed by the water in its passage through it); after half an hour, still 195; so that no diminution following, it was known to be mephitic.

August 30th, the same quantity of the air of my garden, with the nitrous, occupied 205; after half an hour it was diminished to 145, which being deducted gave 60, the state of the air that day; and so of the rest.

The medium state of the air of the atmosphere, in upwards of two hundred experiments, was 60° or 61°.

EXP. I. Sept. 13th, it was in the worst state I ever observed it, 58°, the barometer being 30.30, thermometer 69°, with a calm, clear sky, wind S.E. air dry and sultry, no rain having fallen for above a fortnight; on the same day we had a slight shock of an earthquake.

EXP. II. Sept. 20th, much rain falling, barometer 30.00, thermometer 60°, wind being South, it was 63°.

EXP. III. The next day, Sept. 21, a high wind cleared the air, barometer 29.50, thermometer 52°, the air was 64°. It was the same Oct. 5, the wind high and Westerly. This was the purest I ever observed.

EXP. IV. I have only observed it so good as 68° in three instances, August 16, Sept. 20, and 29; these were all showery days, with a brisk wind.

EXP. V. As to the influence of the different winds upon one atmospheric air, my experiments are as yet too few to ascertain it. I have generally found it the purest during

during Westerly winds, and the worst when it blew from the Easterly points.

EXP. VI. The difference of the air a little way out of the city, from that in the city itself, is perceptible enough. August 9th, the air of the city was  $59^{\circ}$ , beyond the city walls  $62^{\circ}$ . On the 11th of the same month, the first was  $60^{\circ}$ , the last  $62^{\circ}$ .

EXP. VII. Common air being briskly agitated with water for half an hour, was found to be made worse. In one experiment it was reduced from  $59^{\circ}$  to  $57^{\circ}$ ; in another, from  $61^{\circ}$  to  $59^{\circ}$ ; in a third, from  $61^{\circ}$  to  $57^{\circ}$ ; in a fourth, from  $62^{\circ}$  to  $58^{\circ}$ . Air obtained from glazier's putty by the nitrous acid was meliorated by the same process.

In order to find the effects of animal exhalations upon air, the following experiments were made.

EXP. VIII. The air of my bed at night I found to be  $62^{\circ}$ , the next morning it was reduced to  $58^{\circ}$ ; this was several times repeated. The diminution here will appear very considerable upon observing, that it was the effect of the breath, &c. of a single person, in a large, airy room, the bed-curtains always open, except on the side facing the window, which is quite open to large gardens, and never shut with curtains. It fully shews the unwholesomeness

fomenes of small rooms, close beds, &c. especially in diseases.

EXP. IX. Some air which I had respired as long as could be without manifest inconvenience, was by it reduced from  $62^{\circ}$  to  $40^{\circ}$ . This illustrates the preceding experiment.

EXP. X. A small piece of fresh veal was put into a phial containing eight ounces of common air, and suffered to remain therein twenty-four hours: the flesh was then perfectly sweet, but the air was much injured, being diminished from  $64^{\circ}$  to  $55$ . Being left together twenty-four hours longer, the air was reduced to  $10^{\circ}$ , or rendered nearly mephitic; yet the flesh was not putrid, only smelling rather faint and musty.

It is evident from hence, that something had escaped from the flesh, whilst yet void of any putrid smell, so as to render the air very noxious: I suppose this effluvia to be pure phlogiston. Hence it seems, that this principle is capable of rising, *per se*, uncombined with the saline part of animal bodies, the union of which is supposed to give the putrid smell. It proves Sir JOHN PRINGLE's supposition, that phlogiston, when single, is imperceptible to the smell; but I think it also shews it to be pestilential. In our experiments it was devoid of smell, consequently contained no mixture of volatilized acid; yet it  
had

had the common property of all putrid effluvia, that of rendering common air noxious.

EXP. XI. Air taken from within a privy was found in several experiments to be equally good with the common atmospheric air. One trial only gave a different result; here the external air being  $62^{\circ}$ , that of the privy was only  $60^{\circ}$ .

The result of these experiments was contrary to my expectation, and I was not satisfied without making several trials. Sir JOHN PRINGLE observes, that the *fæces humanae* are, perhaps, in a natural state little if at all infectious. These experiments confirm the justness of his supposition. The recent *excreta* of a person in perfect health are here understood; in putrid diseases they must necessarily partake of the general state of the system, and become very noxious and infectious.

EXP. XII. The following experiments were made to discover the effects of vegetable effluvia upon air. They were put into a phial of air, containing eight ounces, immediately after being gathered out of my garden; the time of standing together half an hour, except in a few cases particularly noticed.

Flowers of Ulmaria, diminished it from . . .	63 to 52
Ten-week Stocks, . . .	63 to 53
Mignonette, . . .	60 to 54
Calendula vulgaris, . . .	60 to 54
French ditto, . . .	60 to 55
Nasturtium indicum, . . .	60 to 55
Carnations, . . .	60 to 56
Tree primrose, . . .	60 to 56
Antirrhinum, . . .	60 to 57
Leaves of Sage . . .	61 to 55
Thyme, . . .	61 to 56
Mint (common) . . .	61 to 57
Ditto (pepper) . . .	61 to 57
Parsley, . . .	61 to 57

It is evident from these experiments, that vegetables, when fresh and vigorous, exhale a noxious matter in considerable quantity, which quickly renders common air noxious. This is most remarkable in the flowers, next in the leaves, and this in proportion to their firmness and texture.

EXP. XIII. In the last experiments we have said, that the air only stood in contact with the vegetables half an hour; let us see here what effect a longer time of standing together may have, *viz.* 16 hours.

Flowers

Flowers of Ulmaria diminished it from . . .	60 to 2
Ten-weeks stocks, . . . .	60 to 1
Leaves of Sage, . . . .	61 to 9

The vegetables were at the end equally sweet as when first gathered and put into the phial of air.

These facts are very curious, interesting, and convincing. It is amazing, that vegetables, whilst fresh and free from the least degree of putrefgency, should have such a noxious tendency as to spoil the air, and render it not only useless but fatal to animal life, and that in so short a time.

We have here a striking example of the necessity of faithful experiments: by them alone we can add certainty to science, and develop nature in her most secret and abstruse operations; and as she is unchangeable in herself, every discovery extorted from her is immutable. For want of attention to this laborious but sole method of coming at truth, it is a pretty general opinion in the world, that even rotten vegetables are little noxious: and a late author, whom I only mention because his book is pretty generally read, in a chapter upon putrid fevers and infection, expressly says: “The effluvia of rotten vegetable matters have little effect in contaminating

“ the air; from some experiments it appears, that they  
“ possess rather an antiseptic virtue.”

We know, however, by fatal experience, that both animal and vegetable substances, when in a corrupted state, are the obvious sources of the most dreadful and alarming diseases, from the mildest putrid fever up to the plague itself. Sir JOHN PRINGLE gives us an instance of the jail or hospital-fever, caused by the infection of a gangrened limb. A dreadful fever was caused at Venice by a quantity of corrupted fish; and at Delft by putrid cabbages and other vegetables. Many instances of this kind may be brought, by which countries have been almost depopulated.

But it is no wonder that animal and vegetable matter, when in a state of absolute corruption, should be pregnant with such dreadful effects. Instinct leads us to fly from the danger when we perceive the cadaverous smell.

The ninth, tenth, twelfth, and thirteenth experiments demonstrate, that our senses are by no means capable of distinguishing infection, nor, by warning us of the danger, of leading us to avoid it. They shew, that both animal and vegetable matter, when perfectly fresh, sweet, and devoid of putrescence, exhales somewhat of a very noxious nature, inducing a putrid state in the living body, which proves destructive to animal life.

Hence I do not hesitate to declare, that in jails, hospitals, and other crowded places, we ought not by any means to estimate their wholesomeness by the absence of disagreeable smells alone. The principle of disease may lurk therein unperceived by our limited senses. The method used in these experiments is the only true one by which we may judge with some degree of safety.

The crowding together of a number of men in camps, hospitals, jails, sick rooms, &c. will presently generate a most malignant and infectious fever; and in a very short time, especially if the place be close, unventilated, and the weather hot, the most fatal effects will follow. Of this we have a most remarkable example in the affair at Calcutta.

Mr. HOLWELL and one hundred and forty-five more people, in perfect health, were, by order of the vice-roy, shut up in a place of confinement, at seven o'clock in the evening. The place was 18 feet by 18 feet, containing 324 square feet, so that there was a square for each person of  $26\frac{1}{2}$  inches by 12 inches, which was sufficient to hold them without pressing violently upon each other. The weather was extremely sultry, and the place of confinement having only one small grated window to the West, the air within could neither circulate nor be changed. In less than an hour after their being inclosed, many of the

unhappy people were seized with violent difficulty of breathing, several were delirious, the place was filled with incoherent ravings, exclamations, and cries of distress: the cry of *water, water*, was predominant; it was handed to them by the centinels, but had no effect in easing their thirst. Before eleven o'clock many were suffocated, or died violently delirious. By twelve o'clock all that survived, except a few at the grate, were to the highest degree phrenetic and outrageous; they now found no relief from water, but air could not be procured. Soon after, those at the grate grew so insensible, that we have no account of what happened till they were released from their confinement at six o'clock next morning. Such was the effects of animal effluvia in a close and unventilated place in the space of eleven hours, that, out of one hundred and forty-six souls, no more than twenty-three came out alive, and those in a high, putrid fever, of which, however, by fresh air, &c. they gradually recovered.

In all confined places, in proportion to their airyness, we find more or less of this. In hospitals, though the wards may give no marks of it by any apparent dirtynes or disagreeable smell, we may observe its effects; diseases which usually admit in private practice of an easy cure, are often very tedious, and apt to assume anomalous symptoms.

**symptoms.** Healthy persons, admitted for the cure of recent wounds and other accidents, soon become pale, lose their appetite, and are generally discharged weak and emaciated, but soon recover by the benefit of fresh air. In some hospitals the cure of a compound fracture is rarely seen; in private practice, and a pure air, such cases seldom fail. Such and many more are the effects of bad air, which, though not virulent enough to cause a putrid fever in its more malignant form, is yet sufficient to excite it to such a degree as to undermine the constitutions of the patients, and render the disorders, for which they were admitted, anomalous, tedious, and fatal.

We have demonstrated, that the effluvia of vegetables, even whilst perfectly sweet and fresh, are equally poisonous with those from animal substances. The vegetables were separated from their parent plant, consequently not in a growing or vegetating state.

**EXP. XIV.** Being desirous of finding the effects of effluvia from ripe fruit upon air, six ripe gooseberries sliced were inclosed sixteen hours in a phial with eight ounces of common air: the air being then put to the test, was found to be diminished from  $62^{\circ}$  to  $40^{\circ}$ .

Hence:

Hence it appears, that fresh fruit have, in common with other vegetable matters, a great power in polluting the air, and rendering it noxious.

EXP. XV. In order to find whether any part of the pernicious effects of vegetables upon air in the twelfth experiment might be owing to their odorous particles, the following experiments were made. In each, the quantity of inclosed air was eight ounces; the time of standing together sixteen hours.

10 grains of Musk diminished it from . . . . .	63 to 62
Half a drachm of Camphor, . . . . .	63 to 62
Affa-foetida, . . . . .	62 to 62
Saffron, . . . . .	62 to 62
Opium, . . . . .	60 to 58
Vol. Sal. Ammoniac. . . . .	60 to 58

Musk and camphire were selected as examples of essential oils; the first of the animal, the second of the vegetable class. The affa-foetida as an instance of the foetid odour; opium of the narcotic. Saffron, from its mode of preparation, is incapable of corruption whilst kept dry, and could give nothing but pure odour. The volatile salt was an example of the volatile odour.

Hence we find, that pure odour has little, if any, effect in polluting the air. For where any difference occurred,

occurred, it is so small, that I attribute it rather to some little inaccuracy in conducting the experiment. Nor did I think it necessary to repeat the trials, being satisfied that their poisonous effects in the twelfth and thirteenth experiments were not in the least owing to their odour, but to their organized structure, tending to dissolution from the time they are deprived of nourishment; such is the perfect agreement between vegetable and animal substances.

It is demonstrable from hence, that the filling of rooms with nose-gays and bunches of flowers is by no means a safe practice, especially in close rooms or sick chambers; their effluvia are of so noxious a nature as quickly to render the air unfit for the purposes of respiration, and cannot fail of having bad effects upon sick and valetudinary people in particular.

But it is also evident, that the odorous parts of vegetables, when separated by art from the putrescent, are by no means hurtful. Hence, except in particular constitutions, or in cases where their stimulus may be hurtful, they may be safely used as agreeable odours, and to obviate the smell in sick rooms, &c. The volatile alcali, as Sir JOHN PRINGLE observes, appears in this view perfectly innocent,

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What is here said is understood of plants gathered and separated from the roots. Dr. PRIESTLEY discovered a different property in them when in a vigorous, growing state, they then absorb from the atmosphere; but this ceases with their life, they then exhale putridity, and hasten to dissolution.

We come next to another, not less curious and important, part of our experiments; the effects of the effluvia from moist, marshy, and other kinds of soils, upon air.

This subject, as particularly connected with our art, regarding the endemic diseases of different countries, and a plentiful source of the most dangerous diseases, has much employed the attention of physicians and philosophers. The nature of *miasmata* is, as far as I know, as yet but imperfectly understood; hence general unanimity of opinion is not to be expected: nor can a perfect coincidence in the result of experiments be at once attained, especially if made by persons with different views, and under the influence of different ideas and perhaps prejudices.

In order to attain truth, we must take faithful experiments, made with sedulous observation, for our guides; we shall find them to reflect mutual light and truth upon each other. Thus we gradually lift up the veil of nature, and become acquainted with her genuine form; nor let us

imagine

imagine her ways to be inscrutable; it was merely through ignorance that the ancient Egyptians covered Isis with a veil, making her declare that no mortal could lift it up.

EXP. XVI. The air over the river Ouze was constantly purer than that of my garden by two or three degrees.

EXP. XVII. The same was observable in the air over the foss. This was at a time when, in consequence of floods, the current was pretty rapid, all the mud and marshy ground being covered to a considerable height with water.

I next tried what effect the same waters might have upon air, when confined together. Two ounces of the water was put into an eight-ounce phial, so that there were six ounces of air; being corked up, they were suffered to stand together sixteen hours.

EXP. XVIII. The air from the Ouze water was equally good as at first; and this in several experiments.

EXP. XIX. The same was the result in the foss water. It was perfectly free from mud, yet not so clear as the river water, and had some of the *lens palustris* swimming in it.

Hence we find, that the air was not any way polluted by standing over the surface of water. Perhaps if longer time had been allowed in the nineteenth experiment,

the *lens palustris* might have grown putrid, and hurt the air.

EXP. XX. Some of the fogs water was next tried; so foul as to deposit a muddy sediment upon standing.

In one experiment the air was reduced from 62° to 58°; in another, from 62° to 57°; in a third, from 60° to 56°.

EXP. XXI. It has been observed by those physicians who have had the most opportunities of being acquainted with the diseases peculiar to low, stagnant, and fenny situations, that they seldom begin to appear until the water is so far evaporated, that the black and slimy mud begins to appear. In order to know this, the following experiments were made.

Two ounces of the black stinking mud of the fogs was put into the eight-ounce phial of air; being closed, they were suffered to remain together twelve hours. The air in twelve trials being put to the test, the results were as follow.

In seven experiments the air was reduced from 62° to 34°; in three, from 62° to 36°; in two others, from 60° to 35°.

These are convincing examples of the noxious effects of the effluvia from putrid bogs and marshes. Although I was perfectly convinced of this by the authorities of

Sir

Sir JOHN PRINGLE<sup>(a)</sup>, Dr. LIND<sup>(b)</sup>, CLEGHORN<sup>(c)</sup>, &c. as also by my own reflections and observations; yet I was pleased to prove it in my own study, and to be able to bring it to the evidence of the senses. It is not a little satisfactory to prove, by modern experiments, the truth of observations made in remote antiquity.

A late ingenious author<sup>(d)</sup>, from experiments made with raw flesh suspended over bogs, finding that the effluvia rather retarded than hastened putrefaction, ventures to declare, that he is “ even inclined to doubt of “ their (marsh effluvia) insalubrity in any respect.”

But it should be remembered, that an atmosphere, already saturated with putrid matter, was by no means a proper *manstruum* for taking off and suspending a farther portion of putrescent matter.

And we ought to consider, that *miasmata, aequa ac medicamenta, non agunt in cadaver.* As all impressions upon our system are made through the medium of the nerves, no motions can be excited, nor farther *inertia liquidi nervosi* be produced, in bodies divested of nervous energy. My experiments prove, that marsh effluvia are poisonous to a living animal; yet they may pro-

(a) Diseases of the Army, 8vo.

(b) Essay on the Diseases incidental to Europeans in hot Climes.

(c) Diseases of Minorca.

(d) Experimental Enquiry into the Causes of putrid Diseases.

bably act as an antiseptic upon the dead one. Fixed air is a powerful antiseptic in the one, but is deadly to the other. Nitrous air preserves all flesh from corruption after death; yet let any living animal but once breathe in it, and it instantly expires. Some of our bogs have the singular property of preserving dead bodies not only sweet but pliable for many years; but we are certain they are at the same time deadly to living animals.

EXP. XXII. A fourth part of an eight-ounce phial was filled with the same mud as in the last experiment, but so much dried in the sun as to be easily rubbed into a powder, the rest being air; after being corked, they were set by for twenty-four hours, and in the interim frequently agitated. The air being at the end put to the test was scarcely altered, the greatest diminution in several different experiments was only from  $62^{\circ}$  to  $60^{\circ}$ . So that the air was yet quite good, although they stood double the time of that in the last experiment.

Hence it is evident, that bogs and marshy grounds, when dry, or perfectly drained of their moisture, become healthy, and emit no noxious exhalations.

This illustrates the observation, that such situations are not liable to produce their peculiar diseases during the dry seasons, or after being well drained. And it is observed, that in the most unhealthy of our settlements

in Africa, the East and West Indies, the inhabitants are at such times healthy. But when the wet seasons begin, the scene is reversed; the air immediately becomes vitiated, polluted, and destructive; putrid fevers arise, and spread destruction over the country. The ingenious Mr. IVES gives a dreadful instance of this, and of the diabolical revenge of the Arabs, when they think themselves injured by the Turks at Baffora: they, by breaking down the banks of the river near that city, lay all its environs under water. After the water is nearly evaporated, the mud and other impurities corrupting, pollute the air to such a degree as to cause a most mortal fever in that populous city. This was the case when Mr. IVES was there: of this fever fourteen thousand souls perished; and of the Europeans settled there only three escaped with life: a most horrid mode of revenge, and a dreadful example of the deadly effects of marshes and stagnant waters in hot climates. Let us see if we can prove this by actual experiments.

EXP. XXIII. To the same powdered mud used in the last experiment, was added as much water as was required to bring it to the same consistency with that in the twenty-first experiment. This being inclosed with six ounces of air as before, stood twenty-four hours.

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The air had then contracted a noisome smell, like a new-cleaned ditch, and was diminished from  $62^{\circ}$  to  $49^{\circ}$ . Several experiments gave the same results: on standing longer, it was diminished from  $62^{\circ}$  to  $29^{\circ}$ .

This experiment proves and illustrates the effects of moisture co-operating with unhealthy soils in producing their pernicious effects. Moisture to a certain degree is necessary to every kind of fermentation; hence I suspect, that by the falling of a certain quantity of rain upon marshy grounds, a fermentation immediately commences in the putrid soil, a quantity of vitiated particles are set at liberty, by which the air is polluted. The degree of fermentation is influenced by the degree of heat, and the greater or less quantity of moisture.

EXP. XXIV. To the mud used in the last experiment, so much more water was added as to dilute it so that, upon subsiding, a considerable height of water swam above it; it was confined with the air, and stood as in the last experiment.

The air being then tried by the test, it was in no instance found farther diminished than from  $62^{\circ}$  to  $56^{\circ}$ .

This experiment was made with a view of discovering the effect of marshes and bogs when laid under water; and we find that their danger is in a great measure obviated by it: so that the putrid fermentation is either prevented

prevented by too much moisture, or the effluvia are absorbed in passing through the superincumbent bed of water: perhaps the cold generated by evaporation may have some effect.

This fully proves the propriety of Sir JOHN PRINGLE's remark, where, in giving cautions for avoiding diseases arising from putrid air, he says, " As for cantonments in marshy grounds, if the troops must remain there in the dangerous season, it will be better to float the fields entirely, than to leave them half dry; for the shallower the water the more it will corrupt, and the evaporation will be greater in proportion." How beautifully is this illustrated by the twenty-first, twenty-second, twenty-third, and twenty-fourth experiments! An instance of the perfect agreement of faithful observation with truth and nature.

EXP. XXV. Two ounces of dirt swept from the streets were inclosed in the phial as before; after standing together twenty-four hours, the air was found to be diminished considerably, from  $62^{\circ}$  to  $50^{\circ}$ .

Hence it appears how well the magistrates consult the health of the inhabitants, as well as the neatness of cities and large towns, by enforcing due attention to the cleaning and paving of the streets in their respective districts.

EXP. XXVI. The same quantity of loamy, vegetable earth, out of my garden, and brought to the consistence of thick mud by addition of water, was next tried. The air was found but little worse; in one instance only diminished from  $59^{\circ}$  to  $55^{\circ}$ ; in another, from  $64^{\circ}$  to  $61^{\circ}$ .

It is probable from hence, that fine loamy vegetable earth contains little putrescent matter, as it gives little noxious effluvia. The addition of animal and other kinds of manures will much vary their effects in this respect.

EXP. XXVII. A mass of the same consistence was formed of pure clay and water, the other circumstances of the experiment being the same. The air was not found the worse by it in six trials: in one there was only the small difference of  $62^{\circ}$  to  $61^{\circ}$ , certainly the result of some slight inaccuracy.

So that the pure clay soils appear to be favourable to health; they emit no kind of septic or noxious effluvia.

EXP. XXVIII. Wet sand was tried in the same manner, and found to have no noxious effect upon air: from which it may be concluded, that the general notion of the salubrity of sandy soils is founded on truth.

I shall at present conclude with recapitulating a few inferences, which seem to be proved by the preceding experiments.

1. The atmospheric air is rendered worse by a long continuance of dry weather.

It

2. It is purified by rains and winds, especially Westerly ones.
3. It is considerably worse in cities and large towns, than in the country, even at a small distance.
6. It is quickly poisoned by the effluvia from animal bodies, even whilst perfectly sweet and free from putridity.
7. Vegetable matters, when not in a growing state, have a similar effect, and in a degree equally powerful.
8. And this is not any ways owing to their aroma or odorous parts.
9. Phlogiston rises alone.
10. Phlogiston is imperceptible to the smell, *per se*.
11. Phlogiston is, *per se*, pestilential.
12. The absence of disagreeable smells is by no means a criterion of the healthful state of jails, hospitals, &c. or of their freedom from infection.
13. Mere odour does not injure the air, nor do volatile alcalies.
14. The air is generally pure over waters.
15. The air is greatly injured by the effluvia from the thick mud of bogs and marshes.
16. But this is much obviated by laying them under water.

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17. Air is not hurt by such mud when perfectly dry.
18. Air is also infected by the dirt of the streets.
19. Pure loamy vegetable earth has little of such effect.
20. Air is not at all polluted by pure clay soils.
21. Nor by those of pure sand.

